Pulse Detonation Rocket Engines

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The pulse detonation engine (PDE) is an innovative concept for producing thrust for an aerospace vehicle. The PDE injects low-pressure fuel and oxidizer into a tube and initiates a detonation. The detonation wave, which travels through the tube at a very high velocity (~Mach 4 to 6), compresses the combustion products behind it. This high-pressure gas acts on the closed, head end of the tube to produce thrust. By operating at a high repetition rate, the PDE generates a quasi-steady thrust.

Because the propellants are injected at low pressure, the PDE feed system hardware is less complex than that of a conventional liquid rocket engine. The transient nature of the PDE combustion process means that the tube walls are exposed to hot gases for only a small fraction of each cycle, unlike a conventional engine that is continuously exposed to hot gases. Because of these short exposure times to hot gases, active cooling of the the detonation tube may not be required. These simplifications should result in a significant reduction in development and production costs of a PDE.

Another potential advantage of the PDE involves the nature of the combustion process. A conventional rocket engine burns propellants continuously at constant pressure. Thermodynamic cycle analysis shows that the constant volume combustion process of the PDE is inherently more efficient than constant pressure combustion. However, the actual efficiency improvement suggested by this analysis is yet to be demonstrated.

Although advanced development of the PDE has focused on air-breathing applications in recent years, a similar concept can be applied to rocket engines. MSFC has conducted a rocket engine system design study to identify potential PDE configurations for applications such as upper stage engines and small-scale booster engines. The study has identified the key technology issues, and it has defined a technology development plan for addressing these issues.

A technology development program is underway to address the major technical issues. In FY97 MSFC will begin testing subscale PDE hardware provided by one or more contractors. The product of this task will be a prototype PDE that will generate approximately 1,000 lbf of thrust by FY99. The next step in the advanced development program will be to develop and test a PDE at the 10- to 20,000-lbf thrust level.

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Sponsor: Advanced Space Transportation Program

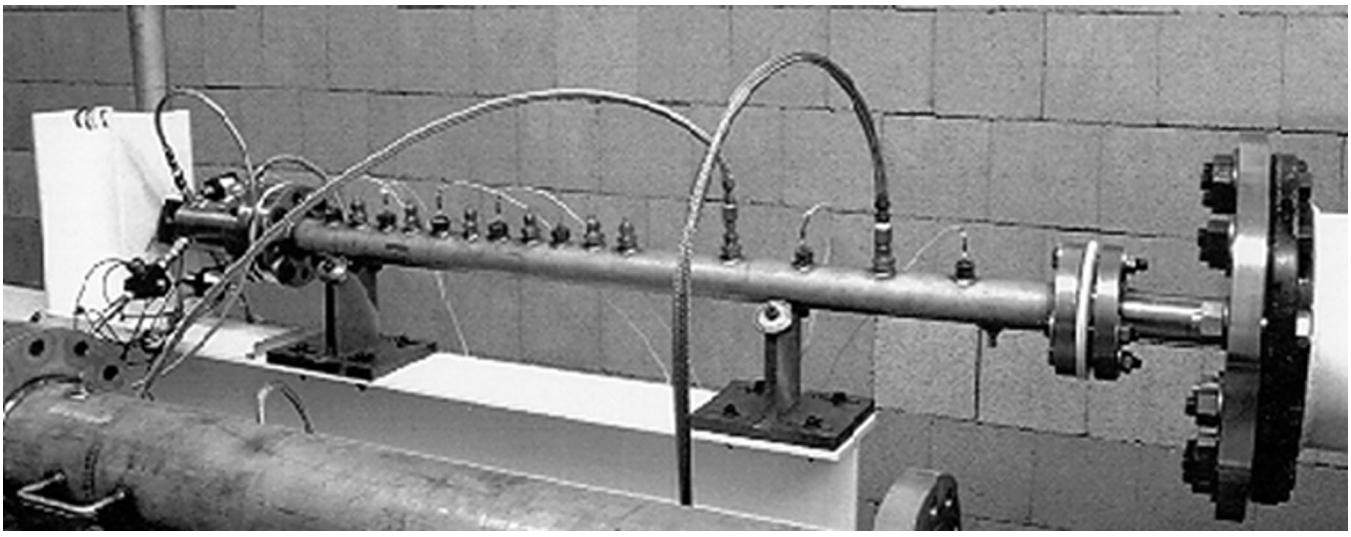

Figure 19.—Prototype hardware for a pulse detonation engine.

University/Industry Involvement: Adroit Systems Incorporated (ASI); Advanced Projects Research Incorporated (APRI)

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